

REMARKS

Claims 1, 11-12, 15, and 48 have been amended to more clearly describe the invention. Support can be found throughout the specification. No new matter has been introduced. Claims 1-48 are pending.

Rejections under 35 U.S.C. § 102(b)

Claims 1-3, 9, 15-17, 22, 24-26, and 30 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,606,163 to Huston et al. ("Huston"). Claims 1, 15, and 24 are independent. Claims 2-3 and 9 depend from claim 1, claims 16-17 and 22 depend from claim 15, and claims 25-26 and 30 depend from claim 24. The Examiner alleges that Huston discloses "determining the temperature of the surface directly from the emission intensity of light." Applicants respectfully disagree.

Independent claim 1

Applicants have discovered a method of sensing temperature that includes providing a temperature sensor including a matrix on a surface of a substrate. The matrix includes a semiconductor nanocrystal in a binder. A portion of the sensor is irradiated with an excitation wavelength of light and the emission intensity of light from the sensor is detected. **An unknown temperature** of the surface of the substrate is determined directly from the emission intensity of light from the sensor. See claim 1.

Huston describes a thermoluminescent (TL) dosimeter system that includes a semiconductor-doped glass material (see Huston at column 3, lines 55-57). Huston describes how thermoluminescent materials are used in radiation dosimetry: "When exposed to ionizing radiation, such as deep ultraviolet, x-ray or gamma radiation, free electrons are generated and are trapped in the material. The electrons remain trapped until a source of heat is applied to the material to stimulate the release of electrons. The electrons recombine with an ion in the material resulting in the emission of light. The amount of light emitted is proportional to the amount of radiation exposure" (emphasis added, see Huston at column 1, lines 33-41).

Huston states that the "semiconductor-doped glass material consists of nanometer-sized, zinc sulfide crystals, activated with copper ions. Exposure to ionizing radiation such as deep

ultraviolet, x-ray or gamma radiation, results in the formation of trapped electrons in the composite glass material. The electrons remain trapped until **the temperature of the material is raised to approximately 150 degrees C.** At this temperature, some of the trapped electrons recombine with the copper ions, producing green light with a wavelength of approximately 500 nanometers (nm)." See Huston at column 3, line 59 - column 4, line 4 (emphasis added).

Nowhere in Huston is the determination of an unknown temperature described. A representative example of Huston's discussion of the relationship between temperature and emission intensity can be found at column 4, lines 40-49:

The glow curve of FIG. 2 shows a beginning of the thermoluminescent (TL) signal at approximately 100 degrees C. and then two peaks. A first peak occurs at approximately 160 degrees C. and a second peak occurs at about 220 degrees C. As the temperature is increased, more light is released, until about 350 degrees C. At this point all of the formerly trapped electrons have recombined with copper ions, and no additional light is produced. The exemplary ZnS:Cu semiconductor-doped glass material can then be used again for another radiation dose measurement.

Huston is describing a radiation dose measurement, not a temperature measurement. Rather than being used to determine temperature, Huston explains that the amount of light emitted is proportional to the amount of radiation exposure. The thermoluminescent material is heated to a predetermined temperature to stimulate the emission of light. The emission intensity that results at a particular temperature (see Fig. 2) depends on the amount of ionizing radiation the thermoluminescent material was exposed to, thus allowing the amount of ionizing radiation that the thermoluminescent material was previously exposed to be determined.

Huston does not describe **determining an unknown temperature**. Applicants respectfully request reconsideration and withdrawal of this rejection.

Independent claim 15

Applicants have discovered a temperature sensor that includes a matrix containing a semiconductor nanocrystal. The matrix is formed from a semiconductor nanocrystal and a binder. The sensor also includes a light source arranged to illuminate the semiconductor nanocrystal with a first wavelength of light, and a detector arranged to detect the intensity of a

second wavelength of light emitted from the semiconductor nanocrystal. The second wavelength is longer than the first wavelength. See independent claim 15.

Huston describes a thermoluminescent dosimetry system. In the system, a light source producing "0.8 to 10 micron light" (column 5, lines 58-66) illuminates a thermoluminescent material including an absorber. The absorber converts the light into heat to stimulate thermoluminescence. The thermoluminescence has a shorter wavelength of, for example, approximately 500 nm (column 6, lines 14-15). Fig. 5, a schematic diagram of Huston's system, shows an optical source emitting 830 nm light and 500 nm light emitted from the thermoluminescent material.

Huston does not teach a temperature sensor that includes a light source arranged to illuminate the semiconductor nanocrystal with a first wavelength of light, and a detector arranged to detect the intensity of a second wavelength of light emitted from the semiconductor nanocrystal, where the second wavelength is longer than the first wavelength. Therefore, Huston does not anticipate claim 15 or the claims that depend from it. Applicants respectfully request that this rejection be reconsidered and withdrawn.

Independent claim 24

Applicants have discovered a temperature-sensing coating comprising a matrix on a surface of a substrate, the matrix comprising a semiconductor nanocrystal in a binder. The examiner alleges that Huston "discloses a temperature sensing layer covering a surface of a substrate (19), the layer comprising: a matrix formed of a ZnS semiconductor nanocrystal in an inorganic glass binder (17)." See the Office Action at page 3.

Huston does not describe a temperature-sensing coating. Huston describes a thermoluminescent material. The material can be fused at one end to an optical fiber (paragraph bridging columns 5 and 6). The thermoluminescent material has a reflective coating at the other end (column 5, lines 54-57). The Examiner contends that the reflective coating is a substrate; however, Huston refers to it only as a reflective coating. The thermoluminescent material is not a coating including a matrix on a surface of a substrate.

Nor is it a temperature-sensing coating. As has been discussed above, Huston describes measurement of radiation exposure. The measurement of radiation exposure includes heating

radiation-exposed thermoluminescent material to promote light emission. The intensity of light emission is related to the radiation exposure. The thermoluminescent material of Huston is not a temperature sensor.

Huston does not anticipate claim 24 nor the claims that depend from it. Applicants respectfully request that this rejection be reconsidered and withdrawn.

Rejections under 35 U.S.C. § 103(a)

Huston in view of Bawendi

Claims 4, 10-14, 18, 23, 27 and 31 have been rejected under 35 U.S.C. § 103(a) as being obvious over Huston in view of U.S. Patent No. 6,322,901 to Bawendi et al. ("Bawendi"). Claims 4 and 10-14 depend from claim 1, claims 18 and 23 from claim 15, and claims 27 and 31 from claim 24.

As discussed above with regard to the novelty of independent claim 1, Huston does not describe determining an unknown temperature directly from an emission intensity of light. Nor is there any suggestion of determining an unknown temperature directly from an emission intensity of light. With regard to independent claim 15, Huston does not teach or suggest a temperature sensor that includes a light source arranged to illuminate the semiconductor nanocrystal with a first wavelength of light, and a detector arranged to detect the intensity of a second wavelength of light emitted from the semiconductor nanocrystal, where the second wavelength is longer than the first wavelength. Bawendi does not remedy either of these defects.

Bawendi describes monodisperse populations of semiconductor nanocrystals and methods for preparing them. Bawendi does not teach or suggest that the nanocrystals have temperature-dependent luminescent properties, or that the nanocrystals would be useful in a temperature sensor for determining unknown temperatures.

Furthermore, there is no motivation to combine Huston with Bawendi. Huston describes a system for measuring exposure to ionizing radiation, such as deep ultraviolet, x-rays and gamma rays. The system incorporates nanocrystals in a thermoluminescent material that emits light with an intensity related to the amount of ionizing radiation the material has been exposed to. Bawendi relates to monodisperse populations of semiconductor nanocrystals and methods

for preparing them. Bawendi is additionally concerned with how the size of the nanocrystals can be controlled in order to control the wavelength of light emission. Bawendi does not discuss thermoluminescence, does not incorporate his nanocrystals in material to be exposed to ionizing radiation, and does not hint at any temperature dependence of the light emission from his nanocrystals. Neither reference is concerned with determining an unknown temperature. A person of ordinary skill in the art would not be motivated to combine the teachings of Huston with those of Bawendi.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

Gouterman in view of Huston and Bawendi

Claims 1-7, 9-20, 22-28, 30-36, and 38-48 have been rejected under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,341,676 to Gouterman et al. ("Gouterman") in view of Huston and Bawendi. See the Office Action at page 4. Claims 2-7 and 9-14 depend from claim 1. Claims 16-20 and 22-23 depend from claim 15. Claims 25-28 and 30-31 depend from claim 24. Claims 33-36 and 38-42 depend from claim 32. Claim 44 depends from claim 43; claims 46-47 depend from claim 45; and claim 48 is independent.

The Examiner alleges that "it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the method disclosed by Gouterman by replacing the fluorescent material with an inorganic polymer-soluble fluorescent material, as taught by Bawendi, in order to provide a fluorescent material that is highly luminescent when irradiated with light when sensing temperatures, and since Huston teaches that luminescent semiconductor nanocrystals are useful as temperature sensors." See the Office Action at page 6.

Even if all the elements of a claim are taught by a combination of references, (which Applicants do not concede to be the case here), there is no *prima facie* case of obviousness in the absence of motivation to combine the references. MPEP 2143.01, citing *In re Rouffet*, 194 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998).

Huston does not teach that semiconductor nanocrystals are useful as temperature sensors, as the Examiner contends. Huston teaches that semiconductor nanocrystals can be incorporated in a thermoluminescent material that can be used for measuring exposure to ionizing radiation.

Gouterman teaches measurement of surface pressure by oxygen quenching of luminescence. See Gouterman at Title. Gouterman does describe that a composition for sensing surface pressure can include a sensor that "produces luminescence... that is dependent on temperature but which has little or no[] pressure dependence," (column 8, lines 39-41). However, in the methods taught by Gouterman, this temperature-dependent sensor is not used to determine temperature, but to eliminate the effect of temperature variations on pressure measurements. Because Huston relates to sensing ionizing radiation, and Gouterman to measuring surface pressure, there is no motivation to combine the two.

Nor is there a motivation to combine Gouterman with Bawendi. Bawendi relates to monodisperse semiconductor nanocrystals, and does not teach or suggest that the semiconductor nanocrystals have any property that depends upon temperature or pressure. Gouterman does not teach or suggest using nanocrystals in a temperature or pressure sensor.

Finally, there is no motivation to combine Huston with Bawendi. It appears that the Examiner is using impermissible hindsight to assemble Applicants invention from the various references, using Applicants' disclosure as a template.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

Gouterman in view of Huston, Bawendi and alleged Prior Art

Claims 8, 21, 29, and 37 have been rejected under 35 U.S.C. § 103(a) as being obvious over the combination of four references: Gouterman, Huston, Bawendi, and alleged Prior Art disclosed by the Applicants.

The Examiner has alleged that portions of the specification, in particular, page 8, lines 28 and 29, are Prior Art. In order to avoid using impermissible hindsight, the Examiner must "take[] into account only knowledge which was within the level of ordinary skill in the art at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure" (emphasis added). *In re McLaughlin*, 443 F.2d 1392, 1395, 170 USPQ 209, 212 (CCPA 1971). In this instance, the Examiner has improperly cited Applicant's own disclosure as prior art.

Furthermore, as discussed above, there is no motivation to make any combination of Gouterman, Huston, or Bawendi. An additional reference purporting to teach the elements of

Applicant : Alfred A. BARNEY et al.
Serial No. : 09/779,437
Filed : February 9, 2001
Page : 14 of 14

Attorney's Docket No.: 14952.0286 / MIT Case 8800

claims 8, 21, 29, and 37 that are missing from the combination of Gouterman, Huston, and Bawendi, would not cure this defect.

Applicants respectfully request that this rejection be reconsidered and withdrawn.

CONCLUSION

Applicants ask that all claims be allowed. Please apply any charges or credits to deposit account 19-4293.

Respectfully submitted,

Date: 6-22-01



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